COMPREHENSIVE FISHERY RESEARCH PROGRAM

The Science Enterprise

The National Marine Fisheries Service develops information needed for the science-based stewardship of the Nation's living marine resources. The six NMFS regional Science Centers encompass 25 principal laboratories, employing over 1,550 scientific and support personnel who conduct a comprehensive, interdisciplinary science program. The scope of their work is temporally and spatially broad and multidisciplinary. The Science Centers provide the scientific knowledge base on which NMFS formulates stewardship policies in concert with its six Regional Offices. Research at NMFS laboratories supports resource management in NOAA, fishery management councils, interstate fishery commissions, and other agencies to facilitate informed decision-making about marine resource management decisions for sustainable fisheries, protected resources, endangered species, and habitat.

Because fisheries are managed on a regional basis, the focus of NMFS research programs varies across Science Centers. Each Science Center develops its own annual research priorities, based upon regional and national needs. The research plans are updated as necessary in consultation with the Regional Offices, Councils, the Program Offices in NMFS headquarters, and NOAA's constituents. The Science Center research staffs are generally organized into teams that focus on specific issues or areas of expertise.

The Office of Science and Technology coordinates the overall NMFS integrated research program. The Science Board, composed of the six Science Center Directors and the Director of the Office of Science and Technology, is responsible for ensuring the integrity and quality of scientific research. The NMFS Science Board addresses national science issues and programs and develops science policy for the agency. All components of the science enterprise function to provide the agency with information that is comprehensive, objective, credible, and effectively communicated.

The NMFS science program has extensive collaborations with academia, many through cooperative agreements and grants. These partnerships enhance and extend the research capability of NMFS. Many NMFS scientists serve as university adjunct professors. This relationship enhances the ability of agency scientists to remain on the cutting edge, while expanding the teaching capability of the university and bringing NMFS expertise into the academic community. Academic scientists also play an important role in the periodic review and evaluation of NMFS research program quality and relevance. The Science Centers work in cooperation with other Federal and state agencies, international entities, nongovernmental organizations, and the private sector, including the fishing industry.

The scale and scope of NMFS research varies. Some major research initiatives focus on the needs of the fishing industry and are performed jointly with industry. For instance, joint studies of harvesting methods and development of more effective fishing gear are underway to reduce wasteful bycatch. Other research initiatives focus on the needs of the FMCs (e.g., determination of the correct mesh size for a specific fishery or determination of the timing and area limits for a specific closure) and on the needs of the NMFS Habitat Conservation field offices to meet their scientific and management mandates under the EFH provisions of the MSFCMA.

The mission of the NMFS scientific enterprise is to ensure that the science products produced and disseminated by the National Marine Fisheries Service are of the highest possible quality. These products reach the decision process through various ways. They include FMC meetings, Technical Committee meetings, written documents that are printed or published on the Web, presentations to policy makers in other fora, and workshops convened to attack specific problems.

Research Components

The MSFCMA mandates strong action to conserve and manage fishery resources that contribute to the food supply, economy, and health of the Nation's marine ecosystems. MSFCMA provisions require NMFS to end overfishing, rebuild all overfished stocks, and conserve essential fish habitat through research and consultations on Federal and state actions that may adversely affect such habitat. These are among our primary stewardship responsibilities.

NMFS is responsible for ensuring that management decisions are based on the highest quality scientific information on the biological, social, and economic status of the fisheries. This includes species' responses to environmental changes, exploitation, and other human activities that affect them and their habitat. Social, cultural, and economic behaviors and incentives that influence human / marine interactions are also addressed. The information is used not just for current management decisions, but also to conserve resources and anticipate future trends, assure future utilization opportunities, and assess the success or failure of the agency's management efforts.

NMFS is also responsible for ensuring that this information, and thus the management decisions for which it provides the foundation, is understood and its validity accepted by user groups and other constituents. To accomplish this, the MSFCMA has mandated that we provide a role for commercial fishers in our fisheries research. An obvious role is in operating charter surveys, but less visible means include providing information and knowledge about changes in species abundance and distribution, ideas and testing of bycatch reduction technology, and reviewing assessment methods and results.

The research priorities of NMFS may be grouped into the four major areas (with several subareas) defined by Congress (see Legislative Background):

I. Research to support fishery conservation and management
II. Conservation engineering research
III. Research on the fisheries
IV. Information management research

More resources are devoted to research underlying conservation and management than all the other areas combined.

I. Research to Support Fishery Conservation and Management

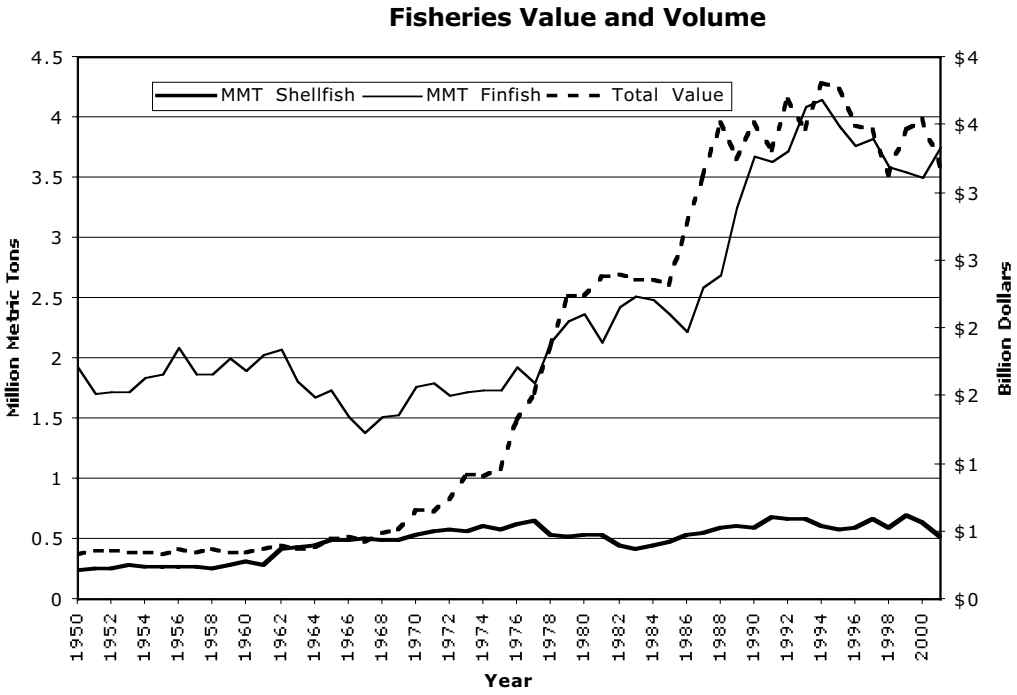
Living marine resources (LMRs) currently support extensive commercial, recreational, and subsistence uses. In 2001, commercial landings by U.S. fishers were 9.4 billion pounds valued at $3.1 billion and U.S. consumers spent about $55 billion for fishery products. The 2002 U.S. marine recreational fish catch was an estimated 420 million fish taken on an estimated 72.0 million fishing trips by more than 12 million Americans (NMFS, 2003e). Once the value-added benefits are calculated, the commercial fishing industry contributes over $28 billion a year to our economy and about $20 billion a year is spent on recreational marine fishing activities (NOAA, 2003e). More than 170,000 people and 123,000 commercial fishing vessels are employed in U.S. fisheries (NMFS, 2003e). The number of vessels greater than 5 net tons is about 23,000 (1987) with a total of 1,000,000 Gross Registered Tons (NMFS, 1996). The secondary sector (processors and wholesalers) employs 71,533 persons (2001) working in 996 plants and 2,414 wholesalers (NMFS, 2003e). These represent just some of the many benefits Americans derive from living marine resources. For example, non-consumptive uses such as diving on coral reefs and whale-watching provide additional benefits.

U.S. fisheries operate throughout the United States in coastal waters, in and beyond the U.S. Exclusive Economic Zone (EEZ), as well as in many rivers and lakes. The resulting catch combined with aquaculture production makes the United States the 5th-ranked fishing nation with 4 percent of the total landings in 2002. In 2002, finfish accounted for 86% of the total landings but only 44 percent of the value (NMFS, 2003e).

Several marine species are under stress from overexploitation, habitat degradation, or both. Over one-third of all fish stocks for which we have reliable population data are overutilized. A few populations may be in danger of extinction, and more are adversely impacted by various human activities. There are many other species for which we have little information. Various factors, both natural and human-related, affect the status of fish stocks and their environment.

The total domestic commercial landings of edible finfish and shellfish since 1950 are shown in Figure 2. Only the tonnage for each and the total value are shown. Domestic landings of all commercial fishery products reached a record high of 4.8 million metric tons (mmt) (10.5 billion pounds) in 1993 and 1994 and a value of $3.8 billion. In recent years, the values of finfish and shellfish landings have been close to equal ($1.4 Billion and $ 1.7 Billion in 2002, respectively). Alaska Pollock ranked first again in terms of weight and total revenues in 2002 (NMFS, 2003e). However, the recent average commercial and recreational yield of all U.S. fisheries resources is still only slightly more than 60 percent of our best estimate of the long-term potential yield. The gross commercial value of the change in yield if all stocks were rebuilt to their long-term potential would yield an additional $1.3 billion to the U.S. economy at the point of first sale (NMFS, 2003b).

Figure 2.



NMFS has undertaken an aggressive plan of action to improve its ability to assess more of the 932 fish stocks that are identified and referenced in federal fishery management plans. To begin implementation of this plan, titled Marine Fisheries Stock Assessment Improvement Plan (SAIP) (NMFS, 2001), the agency received an increase of $2 million in fiscal year (FY) 2001 and $15 million in fiscal year (FY) 2003 and has requested additional funding for FY 2004. NOAA Fisheries does not routinely assess the status of many of the 932 fish stocks because generally they are not targeted in fisheries and have low probability of becoming overfished. Based on a ranking system, the SAIP shows that stocks with the longest history of catches or value rank high for having the best data collection programs and the most comprehensive assessments. This ranking system shows that NMFS is prioritizing its allocated research dollars to conduct status determinations for

those species most vulnerable to overfishing. The plan also indicates that modernization of stock assessments will require significant additional staff, some of which could be filled through cooperative research programs and other partnerships. The SAIP is available at: http://www.st.nmfs.gov/st2/saip.html.

NMFS scientists are actively engaged in research to understand, protect, and restore fishery resources and the habitats on which they depend at both ecosystem and species-specific scales. These research efforts include mapping, spatial analyses, geographic information systems (GISs), and fishery and ocean habitat modeling and characterization, as well as an evaluation of ecosystem approaches focusing on spatially-explicit models and further research into trophic relationships. Additionally, with the increasing need to seek new management approaches to enhance and conserve essential fish habitat (EFH), NMFS is conducting studies on adaptive/management techniques through the identification and use of potential marine reserve areas or refugia (i.e., using areas closed to fishing activities for both recovery and research), and experiments on no-take and limited take zones and time-area closures. NMFS is also exploring the research potential of MPAs to facilitate important experiments in marine ecology and to support recommendations made by the NRC (NRC, 2001). Further, NMFS is evaluating the potential impacts of artificial reef/habitat as well as commercial and recreational fishing activities on habitat and fisheries production. In combination with evaluating these impacts, public education plays a key role in increasing public awareness and support of our living marine resources.

NMFS' research efforts incorporate the use of innovative new technologies and techniques. For example, NMFS is cooperating with other NOAA elements to enhance survey capabilities through research and development of an omnidirectional hydroacoustic system. Airborne LIDAR (Light Detection And Ranging) technology shows promise for identifying near-surface pelagic species. Underwater laserline technology is being developed to facilitate habitat characterization and species identification. Additionally, NMFS uses manned submersibles and remotely-operated vehicles to directly evaluate deepwater species and their habitat.

It is NMFS' responsibility to provide fishery managers with the information needed to make scientifically sound decisions. In order to support fishery conservation and management, NMFS scientists are actively pursuing the following areas of research.

I.A. Biological research concerning the abundance and life history of fish stocks

Activities in this area include collecting catch and effort data, biological sampling, and developing biostatistical analyses for a variety of Fishery Management Plan (FMP) and non-FMP species of exploited fish and invertebrates. Fishery-dependent and fishery independent (i.e., resource survey) sources provide age and size samples, catch composition, and indices of relative abundance. These data are key inputs to stock assessments, fishery management regulations, and the production of status reports for living marine resources and their fisheries.

Larval sculpin. Photo: Jay Clark and Matt Wilson, AFSC.

On October 17, 2003, VT Halter Marine, Inc., and NOAA launched the first of four planned NOAA fisheries survey vessels. Christened *Oscar Dyson*, the 208 ft. ship will be one of the most technologically advanced fisheries survey vessels in the world when it enters service in the summer of 2004. Its capabilities will far exceed those of older NOAA ships. It has been built to meet very specific data collection requirements as well as to meet exacting quietness standards set by the International Council for Exploration of the Seas—to avoid disturbing the fish and mammals it is trying to study. The four ships will either augment or replace aging ships in the NOAA fleet. The second ship is under contract and scheduled for delivery in the summer of 2006. The other two ships, subject to appropriations, will follow in 2007 and 2008.

The biology and life history of species has taken on greater significance in managing the Nation's living marine resources. Describing and understanding migration and distribution patterns, habitat use, age, growth, mortality, age structure, sex ratios, reproductive biology, and responses to environmental variability are key to developing harvest strategies that produce high yields at low risk to the long-term sustainability of the resource base. A variety of scientific methods are employed, including aging using otoliths, histological analyses of gonads, food studies, and observations of spawning behavior. Studies of early life history and fishery oceanography are necessary to understand recruitment dynamics, with the aim of predicting incoming year-class strength. There is an increasing need to identify and characterize discrete stocks. The use of molecular DNA techniques, life history parameter estimates, and ecological habits can aid in determining stock boundaries. This will enable scientists to correctly structure stock assessments and design stock-specific management measures.

The complexity of any assessment is determined by the amount of available data and by the type of information required for scientific advice to fishery managers. Stock assessments can be ordered according to level of modeling effort and sophistication, each one incorporating the underlying data requirements of all preceding levels.

Assessment Levels:

- 0. No Assessment: no assessment has been done.
- 1. Index Only: a time series of relative index of stock abundance calculated as raw or standardized catch-per-unit-of-effort (CPUE) in commercial, recreational,

or survey vessel data; or a onetime estimation of absolute abundance derived from tagging results, a depletion study, or some form of calibrated survey.

- 2. Simple Life History Equilibrium Models: typically applied to life history information; for example, yield-per-recruit or spawner-per-recruit functions based on mortality, growth, and maturity schedules; catch curve analysis; survival analysis; or length-based cohort analysis.

- 3. Aggregated Production Models: data available and used as input for equilibrium and non-equilibrium production models aggregated both spatially and over age and size classes; these include the classic Schaefer model and the Pella-Tomlinson model.

- 4. Size-, Age-, Stage-Structured Models: techniques that include cohort analysis, virtual population analysis, age-structured production analysis, CAGEAN, stock synthesis, size- or age-structured Bayesian models, modified DeLury methods, and size or age-based mark-recapture models.

- 5. Ecosystem Models: assessments incorporating ecosystem considerations with spatial and seasonal analyses. Ecosystem components include one or more of the following: 1) one or more time-varying parameters, either estimated as constrained series, or driven by environmental variables; 2) multiple target species as state variables in the model; or 3) living ecosystem components other than target species included as model variables.

At a minimum, abundance indices are needed for all species to meet the intent of legislative mandates and to provide for early identification of problems. At-risk species may require the highest levels of assessments for effective management, particularly if they are managed near their maximum potential yield.

In an effort to better understand and quantify the status of NMFS stock assessment research, and to determine what needs to be done to improve it, the NMFS National Task Force for Improving Fish Stock Assessments defined three Tiers of Assessment Excellence (NMFS, 2001), which can be summarized as:

- Tier 1—Improve stock assessments using existing data

  a) for core species, conduct assessments that are more comprehensive, more thorough, more timely, better quality-controlled, and better communicated;

  b) for species of currently "unknown" status, mine existing databases of research vessel survey data and / or commercial and recreational statistics for archival information for new analyses to evaluate status determination criteria.

- Tier 2—Elevate stock assessments to new national standards of excellence

  a) upgrade assessments for core species to at least Level 3 (see above Assessment Levels), providing analytical models in which ages or species are aggregated;

b) conduct adequate baseline monitoring for all federally managed species (including rare species).

- Tier 3—Next generation assessments

a) assess all federally managed species or species groups at a minimum level of 3, and all core species at a level of 4 or 5 (size-, age-, or stage-structured models, possibly including spatial and seasonal considerations, species associations, and oceanographic effects);

b) explicitly incorporate ecosystem considerations such as multispecies interactions and environmental effects, fisheries oceanography, and spatial and seasonal analyses.

By quantifying the status of assessments for each of the important species and the amount of resources required to raise the assessment status to the next tier, NMFS has been able to determine the budgetary and other resources that are needed to improve stock assessments.

I.B. Social and economic factors affecting abundance levels

NMFS also recognizes the social, cultural, and economic diversity of fisheries, and the importance of recognizing those differences in creating effective conservation measures. For instance, one critical factor affecting stock abundance is the level of fishing effort. Type and location of both commercial and recreational fishing effort vary across different fishing fleets, groups of anglers, and communities. Also, these groups will differ in their responses to alternative strategies of effort control such as days-at-sea, closed areas, limited access, and bag-limits. NMFS will need new data and models, and modifications to existing models, to capture fully this diversity and its interaction with biological diversity.

NMFS is therefore developing biosocioeconomic models and increasing the collection of data necessary to meet conservation goals and maximize net economic and social benefits to the Nation from living marine resources. For commercial fishing, these data include: vessel and plant level cost and earnings data; ex-vessel prices; and data on social, cultural, and institutional influences such as open access regimes or differing ethnicity-based labor practices. For recreational and subsistence fishing, these data include: information on expenditures, trip characteristics, demographic descriptors, and social and cultural influences on fishing behavior. Knowledge of socioeconomic factors that may facilitate or constrain certain management regimes is essential. Given that some of these data are newly emphasized, national coordination and funding of these activities is important.

Coordinated biosocioeconomic research and analysis will add the element of human behavior to stock dynamics, thus bringing the parameters of our models closer to real world conditions. This, in turn, will improve the predictive power of stock assessments.

I.C. Interdependence of fisheries or stocks of fish

Living and nonliving parts of an ecosystem are linked to each other through physical and biological relationships—for example by food chains or shared habitat use. This information is important if we are to successfully manage our living marine resources in a holistic manner. The health of a fish stock and the merits of alternative harvest strategies cannot be determined in isolation; an ecosystem-based approach is needed to take into account the various factors that affect the status of a stock and the importance of a stock to other components of the ecosystem, as recommended in the Ecosystems Principles Advisory Panel's Report to Congress (EPAP, 1999). The abundance, productivity, and spatial distribution of a fish stock depends on a number of factors, including environmental conditions, habitat quantity and quality, the abundance and health of its competitors, predators, and prey, as well as its symbiotic relationships.

The objective of biological studies on ecosystem interdependence is to understand the functional relationships among ecosystem components. To do so requires that we determine consumption rates and the functional form of feeding interrelationships of fish as well as spatial and temporal variability in abundance and habitat use. We are developing recruitment and multispecies models that incorporate food web and environmental information. The models can be used to help predict long-term impacts of various harvest strategies and environmental trends on yield potential and species composition as well as to investigate effects of predation and compensatory population mechanisms on long-term stability, production, and structure of fish communities under different harvest strategies and environmental regimes. Research activities include:

- Marine food web research through field and laboratory studies of fish consumption rates, feeding selectivity patterns, food preference, and nutritional values of various foods.

- Density-dependent and predator-prey dynamics.

- Fisheries oceanography research to determine how environmental conditions create variability in biological components of the ecosystem.

- Food-web-based dynamic mathematical models that are used to examine how abundance of fish stocks, marine mammals, and other ecosystem components react to changes in environmental conditions and alternative fishery management measures.

Different fishing behaviors, based on use of different gear types and vessel sizes among commercial or recreational fishers, impact ecosystems differently and also have different consequences for non-consumptive user groups, for example in the availability of fish or mammals to view. These different behaviors and impacts and the different values of various ecosystem attributes by different user groups are important to ecosystem management. For example, the development of a wetland for industrial or residential purposes may impact water quality and thus require that a water treatment plant be constructed to replace the natural filtering action

of a wetland, so that an offshore coral reef is preserved. Some critical research areas include:

- The suite of fishing and non-fishing activities available to commercial and recreational fishers for which they are qualified.
- The geographic range within which various consumptive and non-consumptive user groups operate.
- The identification of all user groups, including but not limited to consumptive and non-consumptive as well as those that value the existence of the resource.
- The effect of point and non-point specific sources of pollution on the ecosystem; e.g., hypoxia in the Gulf of Mexico.
- Establishment of safe minimum standards for fishery and other resources in the ecosystems.
- Identification of the role of coastal settlements on ecosystems and stocks of fish.
- Identification of the role of ecosystems and stocks of fish on coastal settlements.
- Determination of the interactions and links between user groups and fish stocks.
- Establishment of a national biosocioeconomic panel of experts to advise NOAA and NMFS on ecosystems, habitat, fish stocks and their interdependence with all affected user groups.
- The amount and value of subsistence, recreational, and part-time fishing.

I.D. Identifying, restoring, and mapping of essential fish habitat (EFH)

The long-term viability of living marine resources depends on conservation and protection of their habitat. The effects of habitat degradation are often insidious, and some losses are not well understood. Others, however, are apparent. We know, for example, that dams for hydroelectric power generation and water diversion for agriculture have severely reduced some valuable anadromous fish runs, and chemical contaminants cause neoplasm and reproductive dysfunction in fish (e.g., winter flounder in Boston Harbor and English sole in Puget Sound). We also know that habitat changes in Florida Bay and Chesapeake Bay have resulted in changes in fish communities, and that environmental perturbations, such as El Niño, change the latitudinal distribution, abundance, and recruitment dynamics of several species on the west coast. It has become apparent that many changes to the habitat are not only the result of natural processes, but also the direct result of human interactions with the environment.

The Sustainable Fisheries Act of 1996 requires fishery management councils (FMCs) to describe and identify EFH in FMPs, to minimize to the extent practicable adverse effects of fishing activities on such habitat, and to identify other actions to encourage the conservation and enhancement of such habitat. It also requires that the Secretary of Commerce initiate and maintain related research. MSFMCA defines EFH as

> "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of EFH: 'waters' include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include aquatic areas historically used by fish where appropriate; 'substrate' includes sediment, hard bottom, structures underlying the waters, and associated biological communities; 'necessary' means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and 'spawning, breeding, feeding, or growth to maturity' covers a species' full life cycle." (Federal Register, 2002).

NMFS will continue to conduct research, analyze data, and provide consultation necessary to: 1) identify freshwater, estuarine, coastal, and oceanic habitats and their utilization by various life stages of living marine resources for spawning, growth, and reproduction, through comparative studies of similar habitats in stressed and unstressed environs as well as comparative studies of different habitats; 2) document the life history of managed fish and determine factors that influence resiliency or sensitivity to fishing; 3) increase NMFS' understanding of the role of the benthic community in the overall ecosystem, the interaction of target fish with benthic communities, and effects of fishing on benthic communities; 4) determine the best methods for restoring LMRs injured by human impacts including harmful spills, vessel groundings, material disposal, and fishing; 5) develop population and habitat recovery models; 6) describe seasonal changes in the character of the water column and seabed, megainvertebrates, and benthic infaunal communities in estuaries and nearshore waters; 7) map EFH using remote sensing platforms (satellite, aerial, and acoustic) along with ground truth and algorithm development to assess habitat type and quality and environmental parameters such as temperature, turbidity, and salinity; 8) work cooperatively with fishers to gain information on existing fishery habitats; and, 9)

Mangrove roots in the Florida Keys provide habitat for juvenile fishes. Photo: William B. Folsom, NMFS.

determine the social, cultural and economic needs of fishing communities with respect to EFH designations. Fishery managers will use the information resulting from these activities to identify, describe, conserve, and enhance EFH.

NMFS Science Centers work closely with the Regional Offices, FMCs, National Ocean Service (NOS) research facilities, the NOAA Damage Assessment and Restoration Program, other Federal and state agencies, and academic and other partners to provide timely habitat information. NMFS works with the NOAA line offices and other agencies to develop the Coastal Change Analysis Program and Coastwatch to apply satellite imagery and aerial photography to habitat mapping, analysis of change in coastal land cover, and assessment of water temperature, color, and circulation.

These research areas and the specific EFH research described for each Fishery Science Center will be used by NMFS and the FMCs to:

- Develop a comprehensive and coordinated base-funded habitat research program in NMFS that interacts with and provides information to habitat managers, the FMCs, and the Offices of Science and Technology, Sustainable Fisheries, Habitat Conservation, and Protected Resources.

- Improve understanding of the distribution and habitat requirements of early life stages of managed species and their prey and predator species.

- Improve stock assessment capabilities and reduce uncertainty.

- Improve habitat conservation, protection, and enhancement capabilities and improve assessment of threats to EFH and managed fish stocks.

- Evaluate and predict how environment and climate signals change the distribution and amount of EFH for important stocks.

- Synthesize research information needs nationally and prioritize habitat research and funding across regions to refine EFH identification, assess and minimize adverse effects of fishing activities, and identify actions to encourage the conservation and enhancement of such habitats as required by the MSFCMA.

- Develop a national database on habitat restoration measures and designs that enhance recovery of biodiversity and value to fisheries.

- Map EFH for managed species in each region, and develop a national GIS database on essential habitat.

- Provide GIS identification and mapping of habitat subject to adverse impacts from fishing gear.

- Restore degraded habitat using restoration options that have a scientific base.

- Cooperate with fishers in gathering information on habitat.

- Study incentives for habitat protection, including literature reviews of incentives for non-fishery activities such as land-based non-point-source pollution.

I.E. Impact of anthropogenic factors and environmental changes on fish populations

Changing conditions of the biotic and physical environment occupied by fish, whether natural or anthropogenic, affect population productivity through mechanisms ranging from sublethal to acute. Detecting such changes is an important task, but determining causal relationships is complex. Anthropogenic effects may be confounded by natural environmental changes or cycles. NMFS is conducting research to unravel these complex relationships to better understand their role in the sustainability of marine fish populations.

Toxic contaminant discharges to the coastal oceans can have a significant impact on the viability of important fish populations. For example, contaminants can disrupt an organism's early life stage development and growth, which in turn can affect their reproductive potential as adults. Such nonlethal effects are not easily identified or characterized, and therefore, are difficult to relate to the sustainability of the fish populations. The quantification and identification of deleterious changes is further complicated by natural and uncontrollable variability within and between fish populations and their supporting food webs.

NMFS will continue to study the potential effects of contaminants on important fish species as well as the sources of variability. To assess the risk to fish populations from different combinations of stressors there must be a linkage made between understanding toxic effects of contaminants to individual organisms and the factors, both anthropogenic and natural, that influence fish populations. There has been growing recognition that marine pollution can disrupt the development and function of the reproductive, endocrine, immune, and nervous systems of marine animals, including fishes, affecting reproductive and growth processes critical to population stability. Because the effects are not always immediately visible, it is difficult to establish the impact on fish populations. Environmental variation at different temporal and spatial scales further complicates the picture. NMFS will continue to study similar habitats in stressed and unstressed anadromous streams, estuarine, and ocean environs in order to understand the effects of pollution on LMRs and their habitats.

NMFS is also studying social and economic causes of habitat degradation, from fishery and non-fishery sources. This research includes coordination with researchers studying land-based activities such as non-point source pollution and urban development. NMFS also engages in research to determine the effects of long-term changes in the ocean climate on LMRs. This information helps assess the true impact of human-induced factors.

Habitat loss and degradation affects riverine, estuarine, and coastal ecosystems. The primary threats come from physical destruction of wetland and other habitats, or access to it, such as through dams, alteration of freshwater flows, eutrophication, and destructive fishing methods. For example, logging contributes to silt-

ation and can destroy salmon spawning habitat upriver and impede their migratory paths. Construction of marinas and docking facilities as well as dredging and disposal of dredged material in estuaries and bays also cause significant habitat impacts. Loss of aquatic habitat (e.g., coastal wetlands or seagrass and kelp beds) resulting from development adversely affects a variety of food webs that are important to adults and juveniles of many marine and anadromous species. Propeller damage to shallow vegetated and nonvegetated habitats not only causes a direct loss of habitat, but results in destabilization of these areas, resulting in increased habitat loss and increased sediment resuspension and turbidity. Changes in freshwater volume and flow rates impact nearshore ecosystems adapted to seasonal discharges of freshwater. Destructive fishing methods can damage EFH and coral reefs.

Nutrient enrichment and eutrophication have a major impact on fish populations in estuarine and coastal waters. This impact is manifested by hypoxia / anoxia accompanying the death of phytoplankton populations (e.g., in the Gulf of Mexico dead zone off the Mississippi River and the western Long Island Sound) and loss of inshore habitat (replacement of eelgrass beds by macroalgae or loss of eelgrass beds due to shading by epiphytes or phytoplankton in Chesapeake Bay, Waiquiot Bay, and Lake Pontchartrain). In addition, changes in nutrient dynamics can create conditions that facilitate harmful algal bloom events that may lead to wild fish kills, shellfish harvest closures, and mass mortalities of farmed salmon in the Northwest. Fishing activities could also change the population dynamics of harmful algal species. A change in trophic webs that decreases grazing on phytoplankton is a major factor in many blooms leading to more or longer lasting bloom events. The potential effect of climate change or environmental variability on harmful algal blooms events is also uncertain (or poorly known).

NMFS is engaging in a variety of research initiatives to study the effects of natural and man made environmental changes on living marine resources and the related ecosystem, social, and economic causes and effects, including:

- Examining the effects of mobile fishing gears, such as bottom trawls, which disturb the sea bottom and damage fragile corals and other benthic habitat.

- Determining the cumulative effects of watershed and regional land cover and changes in that land cover on EFH.

- Ecosystem monitoring for habitat degradation and resource surveys by satellite remote sensing and shipboard and moored instrumentation.

- Developing rationales / methodologies to detect and quantify habitat loss and gain.

- Establishing a GIS database to document and track habitat changes.

- Researching natural environmental variability at temporal and spatial scales pertinent to marine fish populations.

- Developing methodologies to detect and quantify the effects of habitat alterations on fishery populations.

- Conducting laboratory and field research to identify the probable results of contaminant inputs and habitat alterations that significantly affect important fishery species.

- Developing molecular genetic techniques to assess the fitness of fishery organisms.

- Developing models (descriptive and predictive) to assess the risk posed by contaminants and habitat alterations to fishery populations.

- Analyzing and synthesizing existing environmental and fishery data that are available on fishery habitat types and fishery populations.

- Separating the effects of natural versus human-induced climate change.

- Developing methods to identify, map, and forecast harmful algal blooms.

- Determining the effect of fishing on ecosystem trophic structure and population dynamics.

- Assessing, through cooperation with fishers, habitat changes over the past decade.

- Assessing current economic and social incentives for habitat protection or degradation.

II. Conservation Engineering Research

Conservation engineering research is intended to make fishing gear more efficient and to reduce fishing costs, bycatch mortality, and habitat destruction. It is also intended to improve the data provided by scientific surveys of fish populations. This research area includes studies related to gear performance and fish behavior to be used in the development of selective fishing gear to reduce bycatch. Bycatch is responsible for the death of millions of juvenile finfish, including red drum, red snapper, weakfish, Spanish mackerel, and king mackerel. For example, prior to the implementation of bycatch reduction devices (BRDs), it was estimated that between 15 to 50 million red snapper were annually taken and discarded in the offshore shrimp fishery in the Gulf of Mexico. The Food and Agriculture Organization (FAO) estimates that one-third of the world's 16 billion lbs. of bycatch comes from shrimp fishing. Although new analyses are pending since the introduction of BRDs, the most recent studies of bycatch estimate that the ratio of bycatch to shrimp landed is 5.25:1 in the Gulf of Mexico (GSAFDF, 1997). The worldwide bycatch ratio for all fisheries is 0.35 lb. to 1 lb. of target species (Alverson et al., 1994).

A loggerhead turtle escaping from a turtle excluder device in the Gulf of Mexico. Photo: Ian Workman, NMFS.

Since few discarded fish from trawls survive, bycatch constitutes a problem for fishery managers because it represents both an unaccounted mortality in fisheries and an economic loss to harvesters and the Nation. For instance, fishers in another fishery might target the discarded species, or fishers in the same fishery might be able to keep and market those same fish if they were older or larger. Recreational discards are another source of fishing mortality. Information is needed to determine proportions of discards in different recreational fisheries and assess associated release mortality. Additionally, NMFS is encouraging research on ways to increase the survival of recreational releases. Bycatch reduction, then, is critical for the continued existence of healthy fisheries, and is particularly critical when the bycatch includes protected species. Additionally, NMFS conducts research at several of its laboratories on populations of ESA-listed species and marine mammals. Stocks of listed species and marine mammals interact with species managed under the MSFCMA (e.g., competition for food, bycatch). As such, research conducted to support requirements of the MSFCMA also make an important contribution to the conservation and management requirements of the ESA and the MMPA. Along with incentives and other management strategies, one solution to bycatch reduction is to design and operate selective fishing gears, using knowledge of species behavior, gear hydrodynamics, and fishing practices.

An important data collection method used by NMFS to conduct research on fishing gear and its impact on fish stocks, protected species, and habitat, is the deployment of marine resource observers on commercial and recreational fishing vessels. Observers collect information on all aspects of fishing gear operations, including what kind of gear is used, how it is set, how long it is set, and how it is retrieved, as well as information on fish catch and bycatch and incidental takes of protected species. Observers also collect life history data on species of concern, collect biological samples, and support research through tagging of released animals and other activities. Observer data provide information for stock assessment research, for the assessment of gear efficiency, and for monitoring the relative impacts of various types of gear and fishing methods on fish and protected species and marine habitats. Currently, observers are deployed in only a fraction of the U.S. commercial and recreational fisheries managed by NMFS or required to be monitored under the MMPA, but there are initiatives underway to expand the observer program into more fisheries and to more fully integrate observers into fisheries research activities.

Bycatch levels and control measures continue to occupy the attention of most fishery management actions of the regional FMCs. Even when apparent solutions are found, the dynamics and abundance of marine species change in time and

area, and this can shift the character of the problems and require continuous adjustments to their solutions. NMFS will continue to conduct studies to determine the magnitude of bycatch of overfished stocks and options to reduce it. The options may require the design of new types of fishing gear that are more selective for the targeted species. This approach is known as "conservation engineering" and NMFS is working in cooperation with the fishing industry and gear manufacturers to find designs that meet conservation needs while recognizing the financial constraints of fishers.

To determine when gear modifications are the most appropriate response to bycatch problems, NMFS is studying existing programs such as the turtle excluder devices (TEDs) in the Gulf of Mexico and BRDs to exclude finfish from Gulf shrimp trawls and from northern shrimp trawls in New England. By understanding the successes and setbacks in these and other settings, NMFS will be better able to coordinate gear research with the social, economic, and institutional constraints of specific fisheries.

Experimental work with selective fishing gear involves considerable field work on board fishing vessels working under actual fishing conditions. Most trawl gear evaluation includes an alternative tow approach, varying which net is fishing with the experimental gear and comparing the catch results using statistical tests. Underwater cameras allow for examination of the behavioral mechanisms and gear variations that would account for the catch differences.

Growing controversy over the impact fishing gear is having on EFH has resulted in a need to evaluate the impacts. Effects from fishing may include physical disturbance of the substrate, and loss of and injury to, benthic organisms, prey species and their habitat, and other components of the ecosystem. Experiments are being designed to assess the potential effects of all fishing gear types used in waters described as EFH. These studies will include the use of remote underwater cameras, divers, abundance studies, and perhaps research closure areas for comparison. If an adverse effect is identified and determined to be an impediment to reaching target long-term production levels, then the research needed to quantify and mitigate that effect would be the next logical step.

Growing concern over the impacts of bycatch on stocks has resulted in the development of a NMFS Bycatch Plan (NMFS, 1998a). Agency experts with experience in fishery management, stock assessment, and social sciences compiled this plan. It includes proposed national bycatch objectives, specific recommendations concerning data collection, evaluation and management actions necessary to attain the objectives, and a comprehensive assessment of the state of bycatch in the Nation's marine fisheries. The latter is intended to serve as a benchmark from which progress in bycatch reduction can be measured.

NMFS is committed to maximizing the research contribution of the fishing industry and other nongovernment participants in the fisheries. Across the NMFS regions, the industry is providing advice in research planning, in formal reviews of research programs, and, where possible, in research operations. Examples of research involvement include: 1) provision of expertise, ideas, chartered vessels and

crew for surveys and bycatch gear development; 2) keeping logbooks of species catches, including bycatch; and 3) industry efforts to develop gear, gear modifications, and fishing practices to reduce bycatch.

The Saltonstall-Kennedy Grant Program has had direct industry involvement and investment since its inception decades ago. Industry members submit proposals, usually with considerable cost sharing, to conduct research in conservation engineering, to develop fisheries for underutilized species to relieve pressure on traditional species, and to improve the after-catch utilization of captured species.

III. Research on the Fisheries

The condition of the fish stocks upon which the U.S. fisheries depend is steadily improving. New management measures, based on the Sustainable Fisheries Act (Public Law 104-297), have been successfully implemented to halt the decline in stock levels in many U.S. fisheries.

The 2002 annual report to Congress on the status of the U.S. fisheries is the sixth annual report of its kind. It identifies 932 marine fish stocks in the EEZ, an area that extends from 3 to 200 miles offshore and covers more than 2 million square miles, including those stocks that straddle international boundaries and highly migratory stocks (NMFS, 2003c).

Of the 658 stocks whose overfishing status is currently unknown, only 89 stocks or 14 percent are characterized as major; of the 274 stocks whose overfishing status is known, 170 stocks, or 62 percent, are major stocks. Major stocks accounted for approximately 99 percent of the landings in 2001. While minor stocks are important in an ecosystem context, these stocks have not merited the same level of priority given to stocks that are actively harvested (NMFS, 2003c).

Rebuilding programs are approved or are under development for most of the 86 overfished stocks. In 2002, the total number of approved programs stood at 75, including 33 rebuilding programs currently in place for major overfished stocks and 37 for minor overfished stocks. An additional four programs have been approved for major stocks that are not overfished but must continue to rebuild to the average level associated with maximum sustainable yield, and one major stock has an undefined rebuilding target. In some cases, particularly Atlantic highly migratory species, rebuilding programs have been approved, but not yet implemented pending adoption of an international rebuilding regime (NMFS, 2003c).

Excess fishing capacity or “overcapacity” remains a concern in certain U.S. fisheries and occurs when the ability to catch fish exceeds what is needed to harvest the amount of available fish. A recent study of a number of federally managed fisheries reports that 55 percent of the assessed fisheries have some measurable overcapacity, 29 percent do not, and information is lacking for the remaining 16 percent. In some regions, vessels and fishing permits are being bought and retired as part of Federal buy-back programs (NMFS, 2003a).

III.A. Social and economic research

A commercial fishing vessel out of Dutch Harbor, Alaska. Photo: Allen Shimada, NMFS.

Social and economic information has become increasingly important in addressing fishery conservation and management issues. Federal law, Executive Orders, and NMFS policy require social and economic assessments of proposed regulatory or policy changes. The U.S. fishing industry, however, is quite diverse. Competition within and between consumptive users of living marine resources, such as commercial and recreational fishers, and non-consumptive users, who value the existence of living marine resources, greatly complicates the resource allocation decisions fishery managers face. Significant diversity exists between firms within the commercial fishery, and can be seen by the variation in the sizes and types of vessels between fisheries as well as between geographic areas. In addition, oftentimes no clear distinction in an actual fishery exists between commercial fishing firms and individual recreational fishers. Instead, a continuum of activities separate two extreme forms of fisheries exploitation including recreational fishers who sell their catch, headboat and charterboat operations, meat fishers, and catch-and-release fishers. Equally important are individuals who value knowing a particular fish species exists or value the existence of species dependent on a fish stock or stocks; e.g., whales, Steller sea lions, and marine turtles. One consequence of the size and diversity of the users of living marine resources is that the goal of managing U.S. fisheries to maximize the net present value of benefits to the Nation is difficult to achieve.

The application of this broad-based policy to individual fisheries is difficult because each fishery has unique biological, economic, and sociological characteristics that require different types of regulatory approaches. For example, vessel sizes, gear types, crew sizes, and processing, marketing, and distributional arrangements vary significantly among fisheries and geographic areas. Educational levels, household dependence on fishing, preferred target species, and fishing patterns differ across fisheries and fishing communities. Levels and types of social, cultural, and economic dependence on fisheries vary by community and region.

Management decisions must reflect the values as well as needs of many different groups, including commercial and recreational fishers, subsistence fishing communities, non-consumptive users, Pacific Islanders, and Native American tribes (many of which have treaties with the United States guaranteeing certain fishing rights). It is important to identify the demographic, sociological, and anthropological characteristics of the different user groups and how they value fishery resources, including the differences between groups.

Management by NMFS must be done within an economic framework that considers economic efficiency and provides equity or fairness to all resource users. This economic framework considers the transition time associated with a proposed regulation to minimize adverse economic impacts on fishing dependent communities, firms, and individuals. Adequate consideration of these factors requires that NMFS collect and analyze sufficient information about fishing communities, commercial and recreational fishing firms or individuals, and other consumptive and non-consumptive users of our living marine resources. Without sufficient data and analyses, we will have inadequate social and economic assessments and will be unable to determine if our management policies are achieving their intended objectives.

To examine human activities in an ecosystem perspective, research is required on the behavior of consumptive (e.g., commercial and recreational fisheries) and non-consumptive (e.g., whale watchers and non-harvest divers) users of the resource. Some fishers target a single species or species assemblage exclusively. Others fish for a variety of different species by season (an annual round), sometimes switching fishing gears to do so. Yet other fishers are part-time participants only, working in land-based occupations for some portion of the year. Other users of the ecosystem who, for example, swim with sharks or view coral reef communities benefit from a rich and diverse habitat. Still others who never see the resource value knowing that it exists and that it is being conserved for their children, grandchildren, and future generations.

To produce high quality assessments will require new data and models on a number of sectors, including the following:

- The U.S. commercial harvesting sector: Detailed social and economic analyses of the majority of U.S. fisheries is being conducted in conjunction with stock assessments to determine current social and economic costs and benefits in the harvest of living marine resources, and to determine methods to maximize net benefits through innovative management alternatives.

- The U.S. recreational harvesting sector: The recreational and commercial fishing sectors are interdependent and have much in common. Policies aimed at regulating one group almost always impact the other and often affect other sectors of the marine fishing industry. NMFS will assess the net economic and social benefits from various allocation scenarios using demographic, social and cultural information, estimates of anglers' consumer surplus, commercial fishers' producer surplus, and, theoretically, the consumer surplus for commercial catch as well.

- Fishing communities: NMFS is collecting or acquiring from other sources qualitative and quantitative ethnographic, demographic, and economic data important for the social and economic and cultural profiling of fishing communities, including opportunity costs, social structure, and ethnohistorical data, and other data needed for the estimation of net benefits for use in input-output models to determine social, cultural, and economic effects of alternative management strategies.

- Non-consumptive users: NMFS is collecting information necessary to understand the economic and aesthetic value of living resources to non-consumptive users. For example, this includes people who enjoy whale watching, swimming on a coral reef teeming with colorful fish, or simply knowing that there are still fish in the sea. There are cultural and economic impacts of these activities that are just beginning to be understood.

- The U.S. subsistence and traditional use fisheries: NMFS is collecting data to support empirical research using both qualitative and quantitative techniques of fisheries economics, anthropology and sociology, including alternative sources of protein and cultural and ritual uses of the harvested living marine resources, to model and assess social, cultural, and economic factors related to community dependence on the fishery.

- The U.S. seafood processing / wholesale sector: The processing and wholesale sectors are an integral part of the seafood industry. As in the harvesting sector, technological innovations advance the processing and distribution of seafood. NMFS will continue to collect annual data to determine the total number of processing and wholesaling plants, the number of people employed, and the total volume and value processed. NMFS will also increase data collection to support research on social and economic relationships among fishing firms, processors, and wholesalers to better understand the cultural and other institutional influences on the structure of seafood markets (e.g., to develop econometric models of the processing sector to determine the effect of common property resources on capital investment).

- The U.S. trade sector: The U.S. plays a major role in the international seafood market, importing and exporting billions of dollars worth of seafood each year. The U.S. seafood trade market in part determines conditions in its domestic fisheries. NMFS conducts an annual survey to determine our share of the international seafood trade market from which econometric analyses of supply and demand conditions in international markets can be developed to determine how trade agreements impact our Nation's competitiveness in this arena.

- Retail demand for seafood: Social and economic forces in the United States over time have influenced the current makeup of seafood distribution, marketing, and consumption. Population, real per capita income, and the prices of substitutes are three factors that economic theory suggests should explain the aggregate demand for seafood. NMFS is conducting studies to gain a greater understanding of the responsiveness of consumers to changes in prices, quantities, and product quality, their willingness to substitute among various seafood products and other protein sources, their readiness to purchase imported products, the responsiveness of fish and fishery product prices to changes in harvest levels, and the influence of social and cultural factors.

- Economic impact analyses: NMFS will continue to collect economic data to meet the requirements of Executive Order 12866, the National Environmental Policy Act, regulatory flexibility analyses (RFAs), and fishery impact statements for the MSFCMA.

Aquaculture facility. Photo: NWFSC.

- Social impact assessment (SIA): NMFS will continue to collect ethnographic, economic, and biological data related to fishing decision-making processes of captains; investment decision-making processes of owners; information flows within the fishery; and the differential effects of management policies on various subsets of the fishing industry such as absentee owners, captain-owners, and crew members, full-time and part-time fishers, fishers with different household compositions, large vessels and the undertonnage fleet, those who target single species or complexes, and those who fish different gears and species by season.

- Overcapacity: NMFS will continue to assess current levels of capacity of U.S. commercial and recreational fishing fleets (i.e., charter / party vessels), determine optimal levels, and develop approaches to solving the problem of overcapacity.

- Fisheries management: NMFS will continue to seek to integrate the existing biological, economic, and other social sciences information into a single biosocioeconomic framework, or model, from which information can be generated to aid fishery managers in making decisions about our living marine resources.

III.B. Seafood safety research

Intra- and extramural seafood safety research is aimed at continuing the integration of trophodynamic investigations relative to fishery resource health and disease threats, and differential trophic level risk evaluation effects resulting from such threats, be they to other fishery resources, marine mammals, or human consumers. Studies are focused on identifying and determining the characteristics of marine pathogens; improving methods to detect, forecast, and evaluate the ecological significance of harmful algal blooms; as well as developing and applying biological and chemical analytical methods to measure toxic contaminants to restore living marine resources and their habitats. Additionally, when needed, specific highly focused research is rapidly directed to address crisis situations dealing with animal and human health concerns, such as that needed to perform a Risk Assessment to wild shrimp stocks resulting from imported aquaculture shrimp products being infected with various shrimp viruses or reevaluating the human exposure rate from mercury in seafood. These research efforts are conducted primarily at the National Seafood Inspection Laboratory in Pascagoula, MS, as well as at the Northwest and Southeast Fisheries Science Centers.

III.C. Marine aquaculture

The importance of marine aquaculture (mariculture), both in the U.S. and throughout the world, is widely recognized. The production limits of wild stocks are being reached, and most of the increased global production of fisheries products for the last decade has come from aquaculture. In many countries aquaculture is progressing more rapidly than in the U.S., and one-third of the global supply of food fish now comes from aquaculture (FAO, 2003). The annual U.S. trade deficit in edible fishery products is about $7 billion. U.S. aquaculture production in 2001 was about 820,000 pounds (373,000 metric tons) with a value of $935 million. About one-third of this is from marine species. Based on estimated production data, aquaculture probably accounts for more than 25% of the total U.S. landings value. There is significant potential to increase U.S. marine aquaculture production. However, there are technical, environmental, and socioeconomic issues that need to be addressed through basic and applied research and through an examination of policies. These issues include disease transmission, wild forage fish used for feed, escapees breeding with wild fish and eroding genetic diversity, market place competition with wild products, and competition for food and space with wild stocks. NMFS has scientific expertise that can be applied to all of these issues. NMFS has had a long history in aquaculture research and development, stretching back more than 100 years, and has made major contributions to the progress of aquaculture both domestically and internationally. Also, NMFS has environmental stewardship responsibilities and the expertise to assess the appropriate role of mariculture and its potential impacts on wild stocks and habitat quality. Finally, NMFS has responsibilities for permitting aquaculture projects, and it is important to use good science as a basis for establishing clear policies for permitting decisions.

Over the last several years there has been slow but continuous growth in domestic aquaculture production and strong growth in the amount of aquaculture products imported into the U.S. Probably the chief reason for these increases has been the decline in prices for both domestically produced and imported products. From 1999 to 2001, catfish production has been relatively flat while there has been a 10-percent decline in the average price over the last 4 years. Salmon and shrimp imports have risen rapidly while the average price of those imports was falling sharply. The domestic industry is expected to face continuing strong competition from imports and from the domestic poultry and livestock industries, with increased production and lower prices forecast in these sectors (USDA, 2002).

In addition to food production, aquaculture can also play a role in enhancing wild stock populations, assisting in recovery plans for protected species, and can be used to produce nonfood products such as ornamental fish, baitfish, and pharmaceuticals. Expanded mariculture production in the United States has the potential to reduce the pressure on wild stock harvest and help in the rebuilding efforts for those stocks.

Three U.S. Government Departments, Agriculture (USDA), Commerce (DOC), and Interior (USDI), and several of their agencies share aquaculture responsibilities. Their work is coordinated through the Joint Subcommittee on Aquaculture

(JSA). USDA focuses on freshwater species but provides general support to all farming businesses. USDI focuses on freshwater species particularly in operating a national system of hatcheries and in assisting American Indian tribal aquaculture. DOC focuses on marine species and working with the fishery management councils, regulates the development of aquaculture in the EEZ.

There is no single federal agency for assistance to, nor regulation of, the aquaculture industry in the United States. Each facet comes under the jurisdiction of an appropriate authority, such as seafood inspection, environmental protection, food safety, technology or research assistance, licensing, and taxation, just as would other sectors of the U.S. economy.

To ensure that mariculture progresses in an environmentally sound manner, NMFS will concentrate its mariculture research activities in the following broad areas:

- Develop and evaluate commercially viable husbandry technologies for new candidate species.

- Conduct research on the effects of marine aquaculture on habitat and ecosystems, including the removal of forage species as aquaculture feed.

- Evaluate the risk to wild stocks from the introduction of cultured stocks, including determining genetic baselines of wild populations as part of the introduction decision process.

- Establish, with the help of stakeholders, uniform requirements for aquaculture development in the U.S. EEZ under a Code of Conduct for its implementation.

- Develop effective enhancement strategies for aquatic species to help in the recovery of wild stock fisheries and endangered species.

- Integrate aquaculture development with the management of wild stocks, particularly threatened and endangered species.

- Develop environmentally safe protocols for disease prevention.

- Assess the effectiveness of aquaculture as an alternative employment source for fishers in overexploited fisheries.

- Accelerate industrial implementation of aquaculture technologies through demonstration, training, and extension projects for producers, tribes, and community groups.

- Encourage coordination and collaboration of stakeholders to achieve regional and national goals by establishing frameworks for regional cooperation among the private and public sectors.

- Assist associations of producers to prepare best management practices for their respective industries with scientific analysis and assessment of risk.

IV. Information Management Research

Title IV (Fishery Monitoring and Research) Section 401 (Registration and Information Management) of the MSFCMA required the Secretary of Commerce to deliver a proposal to Congress that recommended an implementation strategy for the creation of a "...standardized fishing vessel registration and fisheries information system." This report was completed and delivered to Congress in December 1998, and outlined an approach that integrated all fisheries information required under all applicable NMFS statutory and regulatory requirements, including but not limited to MSFCMA, the MMPA, the ESA, and the Atlantic Coastal Fisheries Cooperative Management Act (NMFS, 1998b). It also includes all data collected under state authority for those states willing to participate. This report was developed in consultation with the U.S. Coast Guard, the states, the regional FMCs, the interstate Marine Fisheries Commissions, other key governmental and non-governmental organizations, and interested stakeholders. Drafts of the proposal were published in the Federal Register for public comment.

The current development of the fisheries information system is based on integrating data collection and data management systems required by NMFS, and linking them with existing state / Federal cooperative statistics programs around the country (i.e., the Atlantic Coast Cooperative Statistics Program (ACCSP); Gulf coast (GulfFIN); Pacific coast (Pacific RecFIN and PacFIN); Hawaii and Pacific islands (WestPacFin); and Alaska (AkFIN)). Linking regional systems will identify and satisfy mutual information needs for states and the Federal government. In addition, gaps in information needs not yet met by these programs will be identified through consultation with industry and policy makers.

NMFS has identified four areas to concentrate its development efforts:

- Core elements for permits and the electronic submission of information.

- Software programs for reconciling commercial landings and logbook information.

- Electronic reporting by fishermen and dealers.

- The integration of systems including standardization of metadata, documentation, and data migration.